



Republic of Zambia

TECHNOLOGY NEEDS ASSESSMENT FOR CLIMATE CHANGE ADAPTATION

Technology Action Plan Report

(Water and, Agriculture & Food Security Sectors)

February 2012

Supported by:



Disclaimer

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FOREWORD

Zambia started the process of a Technology Needs Assessment (TNA) for climate change adaptation with a stakeholder's meeting in September 2011. A similar process for climate change mitigation was initiated in parallel. I am glad to report that both processes have now been concluded and have resulted in the identification and prioritisation of technologies that Zambia should pursue to help our communities adapt to the hazards of climate change.

With the help of her partners, Zambia was keen to engage in the TNA process because the country has seen the reality of climate change for a number of years now. The rise in the frequency of droughts, floods and extreme temperatures, the increase in the unpredictability of rainfall during the rainy season and the increase in mean temperatures are already wrecking hazard on the livelihoods and general wellbeing of our people. What is worse is that the occurrence of such climatic hazards is projected to increase. All our development efforts and the great score we have made over the past decade risk to be reversed by climate change. Clearly we cannot continue with business as usual.

The Government of the Republic of Zambia has recognized this need for some time now and has been preparing ground for action with regards to climate change adaptation. In 2007, it produced the National Adaptation Programme of Action which identified the nature of climate change hazards that threaten Zambia, the most vulnerable sectors and areas of our country and the kind of interventions needed to help our population adapt to these risks. This was followed by the adoption of the National Climate Change Response Strategy and the Pilot Programme for Climate Resilience in 2011. Our national development plans and other national development documents since 2006 have taken climate change as a crosscutting is that should be taken into account in all our strategies and actions. A lot has already been done to respond to climate change and yet the threat remains huge that more needs to be done with even greater urgency.

In conducting the TNA process, consultation with key stakeholders was the core approach taken at every stage. Stakeholders scored and identified the sectors and technologies that needed to be given priority in devising the needed actions. They went on to identify the barriers that would hinder the diffusion of the selected technologies and specified measures required to overcome the barriers. These stakeholder representatives came from civil society, the private sector, academia and government. The determination and desire to forge our effort together is an indication of how climate change adaptation is such an important national issue and is of great concern to all who work to better the lives of our people.

The TNA process on climate change adaptation has produced four reports which should be read together as the unfolding narrative of its results:

1. Technology Needs Assessment Report This report presents the methodology used in the TNA process, how sectors and technologies were identified and prioritized. For climate change adaptation, two sectors – water and agriculture and food security sectors – received the highest scores and were consequently selected for further analysis. In each of the two sectors, three technologies were ranked highest and taken forward for barrier analysis.

2. Barrier Analysis and Enabling Framework Report It documents the barriers to technology diffusion identified by stakeholders and their root causes. Measures and the enabling framework for technology diffusion in the respective sectors and for each technology are also detailed in this report.
3. Technology Action Plans The TAP report provides the steps and actions required to take forward the identified measures in each sector and for each technology.
4. Project Ideas Report Building on the TAP report, this report develops some specific project ideas for water and agriculture and food security. For the water sector, it is proposed to establish a Pilot Climate Change and Water Access (PCCWA) project meant to enhance access to water in Region I despite the climate change hazards the region is exposed to. For the agriculture and food security, it is proposed that a Pilot Smallholder Climate Change Resilience (PSCCR) Project be established to enhance the resilience of small farmers to climate change hazards. Both are pilot projects from which lessons should be learnt with a view to rollout to other areas, especially Region I where these hazards are increasing in prominence.

This has been a lot of work and I am pleased at its successful conclusion. I am grateful to the stakeholders who participated in the process over a period of nearly two years. I thank our partners, the United Nations Environment Programme (UNEP), the Global Environment Facility, UNEP RISO Centre and ENDA for the financial and technical support rendered to the TNA process in Zambia. I wish to also recognize the work of the Consultant, RuralNet Associates Limited, who facilitated the process and documented the outcomes from the stakeholder consultations into the reports mentioned above.

It remains for all of us to work together to ensure that the results of this intense and long process will not go to waste as has been the case in the past with other processes. The Ministry of Lands, Natural Resources and Environmental Protection has made climate change a top priority in its work. I and my colleagues will therefore work very hard to ensure that the projects identified come to fruition. We need the continued support of everyone.

Hon. Wilbur Simusa (MP)
Minister, Lands, Natural Resources and Environmental Protection

May 2013, Lusaka, Zambia

Acronyms

AC	Alternating Currency
BOZ	Bank of Zambia
CB	Commercial Bank
CFU	Conservation Farming Unit
DC	Direct Currency
DWA	Department of Water Affairs
ERB	Energy Regulation Board
FISP	Farmer Input Support Programme
GART	Golden Valley Agriculture Trust
GRZ	Government of the Republic of Zambia
HH	Household
ICRAF	Eastern province by the International Center for Research in Agro forestry
MAL	Ministry of Agriculture and Livestock
MEWD	Ministry of Energy and Water Development
MLNREP	Ministry of Lands, Natural Resources and Environmental Protection
MOF	Ministry of Finance
MOH	Ministry of Health
NAIS	National Agriculture Information Services
NBFI	Non-Bank Financial Institutions
NGO	Non-Governmental Organization
NRWSSP	National Rural Water Supply and Sanitation Programme
NWASCO	National Water Supply and Sanitation Council
PSCCR	Pilot Smallholder Climate Change Resilience
PVP	Photovoltaic System
REA	Rural Electrification Authority
RELO	Research Extension Liaison Officer
SAG	Sector Advisory Group
SCCI	Seed Control and Certification Institute
SNDP	Sixth National Development Plan
SNV	Netherlands Development Organization
TAP	Technology Action Plan
TEVET	Technical Education, Vocation and Entrepreneurship Training
TEVETA	Technical Education, Vocation and Entrepreneurship Training Authority
TNA	Technology Needs Assessment
TWG	Technical Working Group
UNICEF	United Nations Children's Fund
WHO	World Health Organisation

ZACCI	Zambia Confederation of Chambers of Commerce and Industry
ZARI	Zambia Agriculture Research Institute
ZDA	Zambia Development Agency
ZEMA	Zambia Environmental Management Agency
ZNFU	Zambia National Farmers Union

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EXECUTIVE SUMMARY

This is a Technology Action Plan (TAP) report whose purpose is to detail the steps needed to be taken in the relevant sector to diffuse the technologies that were selected at the start of the Technology Needs Assessment (TNA) process and as documented in the TNA report (GRZ, 2012). The TNA report documented the identification, prioritization and selection of sectors and technologies for climate change adaptation in Zambia. Two sectors, the water sector and the agriculture and food security sector, and three technologies in each sector were selected following a stakeholder driven process. The selected technologies were then subjected to a barrier analysis, i.e. an analysis of the likely barriers to transfer the identified technologies. At barrier analysis stage, measures to address the identified barriers in the two sectors were suggested. Both barriers and measures were documented in the Barrier Analysis and Enabling Measures report.

The TAP report is therefore the third report of the TNA process. It provides a short comprehensive description of the actions for adaptation technologies identified under the Water and Agriculture and Food Security sectors. The TAP report is based on the content of the Barrier Analysis and Enabling Measures report. It is expected that this TAP report will lead into the production of fourth and final report, the Project Ideas report, intended to highlight specific project ideas for each of the two sectors. The three technologies prioritized for each of the two sectors at the TNA stage were:-

- Water sector
 1. Rain water collection from ground surfaces - small reservoirs and micro-catchments,
 2. Boreholes/tube wells for domestic water supply during drought,
 3. Erecting a concrete collar/apron around a well for resilience to flooding.

- Agriculture and food security sector
 - Conservation farming with agro-forestry (Faidherbia albida (musangu tree), Tephrosia Vogellii (ububa), Sesbania Sesban and Gliricidia Sepium)
 - Integrated production system (crop-small livestock-fish-poultry-vegetable),
 - Promotion of drought, stress, heat, pest, diseases and soil acidity, tolerant and early maturing crop varieties.

Adaptation Preliminary Targets and Objectives for the Water Sector

The three technologies prioritized during the TNA stage are expected to contribute to the vision of the Sixth National Development Plan (SNDP) for the water sector. This is spelled as *"a Zambia where all users have access to water and sanitation and utilise them in an efficient and sustainable manner for wealth creation and improved livelihood by 2030"* (GRZ, 2011). Specific objectives to deal with climate change adaptation in the water sector in the SNDP are specified as to: (i) achieve sustainable water and resource development for social and economic development; and, (ii) strengthen capacity for disaster risk management, mitigation and adaptation to effects of climate change.

The main target groups for actions on climate change adaptation in the water sector with respect to the selected technologies are communities of Region I. Climate change has been evident in Region I over the

years. The historical rainfall patterns indicate a decreasing trend of annual rainfall (GRZ, 2007). The region is considered a drought-prone/risk area. At the same time, the region is increasingly becoming prone to floods. Most communities in this region face the challenge of accessing clean water for home use, crop production as well as watering their animals.

It is proposed to establish a Project on Climate Change and Water Access (PCCWA) project to cater for the issues observed above.ⁱ The pilot project will target a total of 19,500 households in Region I. The preliminary costs of a five year pilot climate change and water access project were estimated at US\$11.4 million. It is envisaged that as the pilot project shows good results, it could be rolled out to other areas especially Region II where droughts and floods are also increasing in frequency.

Therefore, the objectives for the diffusion of the three technologies prioritized at the TNA stage are thus to ensure that:

1. Communities in Agro-ecological Region I have access to quality water both for production and domestic consumption; and,
2. Communities in flood prone areas in Region I protect their water sources during floods.

Barriers, Measures and Actions for the Water Sector

The barrier analysis classified barriers and measures for an enabling environment under two categories: (i) economic and financial barriers; and, (ii) non-financial barriers. These are briefly restated here under each category. In addition, the action points for the implementation of the proposed measures have been documented.

Actions for Economic and Financial Barriers and Measures

Under this category, the high cost of materials and equipment for construction or installation of the facilities was identified as a key barrier in all the three technologies. Communities, the government and other institutions promoting these technologies are thus unable to provide widely these facilities to ease access to water for the targeted users. High poverty levels in the country as a whole, and rural areas in particular, serve as a backdrop to this barrier. The proposed measures to deal with this included: (i) provision of construction materials at subsidized prices through the Pilot Project for Water Access and the government ; and, (ii) utilizing rail transport in the transportation of bulky good such as cement.

From the action plans presented in a tabular formats in the relevant sections of the report, the justification for actions on financial and economic barriers include the fact that the accelerated infrastructure development in the last ten years which is forecast to increase even further has led to a sharp rise in the demand and prices for materials used in the construction industry. There is thus need for more investments in the manufacturing of construction materials to improve their supply and help reduce their prices. High cost of fuel could be mitigated by a search for cheaper alternative sources including bio-fuels. The high import duties could be reduced by broadening the tax base so that government does not have to maximize its revenue collection from a few sources. Zero rating import duty for a number of years on some critical

equipment could help the uptake of the recommended adaptation technology until such a time when the country is able manufacture these equipment.

The relevant agencies in implementing these measures are both public and private organizations which include Ministry of Lands, Natural Resources and Environmental Protection (MLNREP), Ministry of Finance and National Planning (MoFNP), Ministry of Energy and Water Development (MEWD) and Pilot Project on Climate Change and Water Access (PCCWA).

The actions to deal with the needed financial and economic measures require an enabling environment. Strong institutional arrangements to lobby for the adoption of the proposed measures should be put in place. This could be achieved in two ways. Firstly, the proposed PCCWA project could have within its framework an institutions component with a mandate to lobby for an enabling environment. Secondly, the MLNREP will need to work closely with the institutions component of the PCCWA.. The lobbying could start immediately at the commencement of the 5 year project. However, the activities of lobbying for an enabling environment could continue within the framework and mandate of the identified organizations as long as the need for climate change adaptation remains.

Actions for Non Financial Barriers and Proposed Measures

Three main barriers under this category were identified. First, technical skills for constructing dams and micro-catchments are inadequate because few people were being trained in this discipline. There is need to review the current education system so that people's mindset is changed to begin to value these skills. There is also need to introduce career guide courses in tertiary institutions to create a pool of career guide specialists in the country. Furthermore, higher learning institutions needed to do more to promote these courses through their outreach programs. Secondly, some places in the country were considered not suitable for of borehole/tube wells for domestic water supply adaptation technology due a variety of reasons including geological landscape and pollution of underground water sources. The proposed measures to counter this challenge included (i) producing survey maps to guide suitability of the adaptation technology in the proposed areas; (ii) enforcement of environmental laws and other regulations; (iii) sensitize industries on environmental pollution issues and (iv) review and enforce Land Use Plans. Thirdly, there was inadequate information and knowledge on erecting a concrete apron/collar around the well. To address this it is proposed that forums for inter-departmental knowledge and information sharing on water, sanitation and hygiene be created.

The Department of Water Affairs (DWA) is the most prominent institution identified to take up actions for climate change and water access in rural communities including people living in Region I. The DWA has the mandate of regulating water use but is also an active participant in creating water points for domestic and agricultural production. However, in creating an enabling environment that would promote the adoption of the adaptation technology of erecting a collar around the wells, the DWA would need to work with a range of other organizations. It will need to collaborate with the Ministry of Community Development, Mother and Child Health on community mobilization issues, the Ministry of Agriculture and Livestock on water for agricultural production issues, the Zambia Environmental Management Agency (ZEMA) on environmental regulation as it relates to water resources. Within the framework of the proposed pilot project, a component should be provided for that helps to foster collaborative efforts.

Adaptation Objectives for the Agriculture and Food Security Sector

For the Agriculture and Food Security sector, the SNDP vision is “*an efficient, competitive, sustainable and export-led agriculture sector that assures food security and increased income by 2030*” (GRZ, 2011). This is supposed to be achieved by promoting crops, livestock and fisheries production through higher commercialization. Unfortunately climate change is threatening the country’s potential to realize this vision.

The main target groups in the agriculture and food security sector for climate change adaptation are small scale farmer in Region I. This is a semi-arid with the lowest annual rainfall in Zambia of less than 800 mm. Region I is considered a drought-prone/risk area. The historical rainfall patterns indicate a decreasing trend of annual rainfall (GRZ, 2007). Floods are also increasing in their frequency. Combined with other characteristics of climate change, drought and floods are leading to small scale farmers become more vulnerable to household food insecurity and poverty.

To address these concerns, it was proposed to establish a Pilot Smallholder Climate Change Resilience (PSCCR) project.ⁱⁱ Although this is a separate project from the PCCWA project, synergies could be drawn from the two projects drawn to ensure maximum impact given that they will cover the same region. The PSCCR project will have the following specific objectives:

1. Enable farmers in Agro-ecological Region I achieve higher yields with less water and less chemicals while conserving soil fertility;
2. Help farmers build crop resilience to diseases, pest organisms and environmental stresses; and,
3. Enable farmers spread the risk widely by diversifying their enterprises while in the process making their farming systems more profitable

Barriers, Measures and Actions for the Agriculture and Food Security Sector

These were also categorized into two as presented below.

Actions for Economic and Financial Barriers and Measures

The high start-up cost of capital and inputs was a common barrier mentioned for the diffusion of integrated farming and improved seed varieties. It was difficult for poor farmers to adopt integrated farming as they needed to spend money on new seed varieties, labour and on-farm equipment and infrastructure. The estimated capital cost of a small medium farmer who engaged in mixed production system on a 1.25 ha of land as described here was US\$1,937.37. This was too high for poor farmers to meet. It was admitted that the process of coming up with suitable seed varieties from research to marketing will always make hybrid seed more expensive. One possible way of reducing the cost of hybrid seed varieties is by encouraging seed companies to adopt cheaper methods of producing seeds such as the 2-way cross and establishment of a credit facility for farmers willing to venture into integrated production system.

The action plans to take forward the proposed economic and financial measures for the diffusion of the selected technologies in the agriculture sector are similar to those in the water sector because they deal with the high cost of technology. There is therefore a big overlap in the rationale justifying the proposed

actions and the relevant institutions that should implement them. However, more actions were required from organizations within the agriculture sector under the leadership of the Ministry of Agriculture and Livestock. Agriculture producer organizations like the Zambia National Farmers Union (ZNFU) and consultative bodies like the Agriculture Sector Advisory Group took a lot of prominence. How to make consultation and collaboration effective is seen as critical to the promotion of the prioritized technologies. Secondly, the focus of the actions is much more oriented towards reducing the cost of transmitting information to farmers.

Actions for Non-Financial Barriers and Measures

Integrated farming was said to be labour intensive by its nature but there is inadequate manpower in most households in rural areas to successfully adopt it. The high cost of hired labour compounds the challenge. Farmers should thus be encouraged by the promoters of integrated farming to take up the practice at a scale they could manage and then upscale it gradually. Farm power mechanization could mitigate labour constraints although this again might be constrained by the low financial resources at the farmers' disposal to acquire the necessary equipment. The cost of labour in rural areas of Zambia has been escalating over the years due to inadequate manpower at household level and high rural-urban migration. Promoting agriculture as a business and making it viable for the poor farmers such as through adequate agriculture market channels is an important strategy to ensure that agriculture is appreciated by the Zambian population. This will help to stem the high rural-urban migration of productive young people and to improve the availability of labour at household and community level.

Two other non-financial barriers were inadequate information and inadequate access to improved varieties of crops like cassava, sorghum and millet. Inadequate information was mainly due to the inappropriate restructuring of the Ministry of Agriculture and Livestock which saw the abolition of the RELO position while the research and extension branch which had hitherto fallen under one directorate were elevated to full directorates and started operating in parallel leading to inadequate linkage between research and extension. It has thus been recommended that the RELO position or something playing similar function be re-established. Other measures had to do with effective communication strategies by using cost effective communication channels and ensuring that information dissemination was participatory. With regards to promoting access to improved varieties, it was noted that over the years, it was suggested that government deliberately provides subsidies on seed for improved crop varieties. The Farmer Input Support Program (FISP) could easily be modified so that it covers crops other than maize. In addition, the government can also encourage agro-input dealers through special incentives to open outlets in rural areas as this will inevitably enhance accessibility.

Actions for institutional strengthening in the Ministry of Agriculture and Livestock have been given prominence under the non-economic and financial measures. Of particular concern was making sure that research was strongly embedded in farmers' perceived needs and that the right messages were formulated and effectively communicated to them.

1. Introduction

The Technology Needs Assessment (TNA) for Zambia for climate change adaptation has four (4) main deliverables namely; TNA Report, Barrier Analysis and Enabling Framework Report, Technology Action Plans and Project Ideas. The initial TNA report (GRZ, October 2012) focused on the process of identifying, prioritizing and selecting sectors and technologies to be taken to the barrier analysis stage under the Water and Agriculture and Food security sectors and the selected technologies were as follows:-.

- Water sector
 - I. Rain water collection from ground surfaces - small reservoirs and micro-catchments,
 - II. Boreholes/tube wells for domestic water supply during drought,
 - III. Erecting a concrete apron/collar around the well to improving the resilience of wells to flooding.

- Agriculture and Food Security sector
 - I. Conservation farming with agro-forestry (Faidherbia albida (Musangu Tree), Tephrosia Vogellii (Ububa), Sesbania Sesban and Gliricidia Sepium)ⁱⁱⁱ
 - II. Integrated crop-small livestock-fish-poultry-vegetable production system
 - III. Promotion of crop diversification and new varieties.

The second deliverable to be produced – Barrier Analysis and Enabling Framework – analyzed the likely barriers to transfer the identified technologies and suggested measures to address the identified barriers in the two sectors. Its main aim was to assess and overcome barriers facing the transfer and diffusion of technologies for climate change adaptation in Zambia in the water and agriculture and food security sectors.

The third deliverable is this Technology Action Plans (TAPs) Report which details the steps needed in each relevant sector and for each technology to diffuse the selected technologies. The TAPs report provides a short comprehensive description of the action plans for adaptation technologies identified under the Water and, Agriculture and Food Security sectors. It presents the action plans which are the results of the process, which has led to a selection of several options for groups of measures described in the barrier analyses and enabling framework report. The TAP report is purely based on the content from the Barrier Analysis report. TAPs also deal with crosscutting issues.

After this report, one more deliverable was expected, i.e. Project Ideas report. These are brief summary and specific project ideas for each sector that has been prioritized.

2. Technology Action Plan for Water Sector

2.1 Objectives and Preliminary Targets for Technology Diffusion

Three technologies were prioritized for the water sector at the TNA stage as follows:

1. Rain water collection from ground surfaces - small reservoirs and micro-catchments,
2. Boreholes/tube wells for domestic water supply during drought,
3. Erecting a concrete apron/collar around the wells to avoid flooding.

The technologies were meant to address a number of critical concerns observed. These included the fact that despite Zambia having vast water resources of generally good quality (both surface and ground water), communities living in semi-arid parts of the country in Agro-ecological Region I particularly experienced severe water shortage during the hot dry season a situation that compromised water quality, raised human and animal conflict over water resources and forced households to travel long distances to get water. Women and children are especially vulnerable in this scenario as they are the ones that mostly draw water for domestic use.

The Zambian Government has recognized this concern. The goal for the water sector in the Sixth National Development Plan (SNDP) is thus *"a Zambia where all users have access to water and sanitation and utilize them in an efficient and sustainable manner for wealth creation and improved livelihood by 2030"* (GRZ, 2011). Specific objectives recognize the need for climate change adaptation in the water sector:

1. To achieve sustainable water and resource development for social and economic development
2. To strengthen capacity for disaster risk management, mitigation and adaptation to effects of climate change

The objectives with regards to the diffusion of the three technologies are therefore to ensure that:

1. Communities in Agro-ecological Region I have access to quality water both for production and domestic consumption; and,
2. Communities in flood prone areas in Region I protect their water sources during floods.

For a coordinated implementation framework, it is proposed to establish the Pilot Project on Climate Change and Water Access (PCCWA). It will target a total of 13,500 households in Region I. The number of households to be targeted with each technology and the associated costs are indicated in Table 1. The preliminary costs of a five year pilot climate change and water access project is estimated at US\$17.4 million. It is envisaged that as the pilot project shows good results, it could be rolled out to other areas especially Region II where droughts and floods are becoming frequent in recent years.

Table 1: Preliminary Targets for the Pilot Climate Change and Water Access Project

Technology	Number of HH	Number of Facilities	Cost Per Installation (US\$)	Maintenance Cost/Yr (US\$)/ Facility	Total Cost (US\$)	Project Admin Cost (10% of total costs)	Overall Project Cost
Small reservoirs & micro catchments) ^{iv}	1,500	15	284,000	5,680	4,345,200	434,520	4,779,720
Building a Concrete Apron/Collar on the well	10,000	1,000	4,000	70	4,070,000	407,000	4,477,000
Borehole/ tubewell with overhead tank and a solar powered pump	2,000	200	12,000	240	2,448,000	244,800	2,692,800
Total	13,500	1,215			10,863,200	1,086,320	11,949,520

2.2 A Brief Description of Prioritized Technologies in the Water Sector

A brief description of the three priority technology options and the specific technologies arising from them are provided below. These have been described in detailed in the TNA Report to which reference should be made for a more detailed description.

2.2.1 *Rain water collection from ground surfaces-small reservoirs and micro-catchments*

The aim is to store water for use during seasonal dry periods and where possible during droughts. This is done by collecting water from a river, stream or other natural watercourse which gets inundated by rain water flows during the rain season. This often includes an earthen or other structure to dam the watercourse and form “small reservoirs.”The second was prioritized for diffusion at the TNA stage.

2.2.2 *Boreholes/tubewells for domestic water supply during drought*

Tubewells are a narrow, screened tube or casing driven into a water bearing zone of the sub-surface. Boreholes are tubewells penetrating bedrock, with casing not extending below the interface between unconsolidated soil and bedrock. A hand-powered or automated pump is used to draw water to the surface or if the casing has penetrated a confined aquifer, pressure may bring water to the surface. To enhance the effectiveness of the boreholes it was proposed that they be fitted with a *Solar powered pump for water supply photovoltaic system* with a particular focus on drought prone areas in Agro Ecological Region I. The solar pump would pump water into an overhead tank which later flows down using gravity.

2.2.3 Building a Concrete Apron/Collar on the Well

This option aims at ensuring good quality water in situations of increased occurrence of floods. It involves enhancing wells at design and construction stages for high resilience to flooding and avoid water contamination, collapse of the well or failure by the community to reach the water point when the area gets submerged. The specific technology selected was the building of a concrete apron/collar on the well. This would require changing the design of most wells provided in Zambia by building concrete works on the well and around the well. The concrete rings would form an apron/collar of 1.5m high and 3.0m in diameter. The slope of the base will be 45-degrees, gradual enough to prevent damage to the base during flooding. The wells would be operated with the hand pump.

2.3 General Barriers and Proposed Measures

At barrier analysis stage of the TNA process, barriers and measures in the water sector were identified and categorized into two as follows below.

2.3.1 Economic and Financial Barriers

The common economic and financial barrier to the diffusion of the technologies identified was the high cost of installing these water facilities. This referred to the high cost of machinery and equipment, mobilization of such equipment to the sites where they were needed, installation of the technology and the high cost of materials. For rural communities, these costs were exorbitantly beyond reach. Unfortunately the relevant government departments tasked with the promotion of installing these facilities are poorly equipped due to the high cost of equipment.

2.3.2 Non-Financial Barriers

A variety of non-financial barriers were identified including: (i) The lack of technical skills and experience necessary in designing small reservoirs and micro- catchments technology; (ii) lack of skills in the construction of small reservoirs and micro- catchments; (iii) The fact that some places in the country are not suitable for this type of technology (bore holes/tube wells) and, (v) Inadequate information and knowledge.

2.3.3 Economic and Financial Measures

Policies were required to reduce high import duties on equipment for the installation of the facilities. This could be done, for example, by zero rating import duty on bulk equipment for construction of technologies for climate change adaptation for a period of at least 5 years. In addition, the country needed to promote investments in the manufacturing of materials used in the construction industry to bring down their price.

2.3.4 Non-Financial Measures

Measures to deal with the non-financial barriers in the sector were as varied as the barriers identified. It was recommended that there be measures to promote: (i) Skills related to the construction of reservoirs

and micro-catchments; (ii) Enforcement of regulations to ensure the safety and protection from depletion of underground water sources; and, (iii) Use of land use plans to ensure that activities are not sited in wrong places.

2.4 Action Plan for Rain Water Collection From Ground Surfaces - Small Reservoirs

2.4.1 *Target for Technology Transfer and Diffusion*

The main target groups for actions on climate change adaptation in the water sector with respect to this technology are communities of Region I to address the challenges faced by communities of accessing clean water for domestic use, irrigation and livestock. With respect to small dams and micro-catchments, the pilot project will target 1,500 HHs for water supply and animal watering (see Table 1 above).

The economic benefits of the technology arise from the opportunities that stored water presents for various uses including for irrigation, watering of livestock, fish farming, etc. Besides this is the potential for accessing safe water for domestic use. Environmental benefits include how widespread rainwater storage capacity can greatly reduce land erosion. The cost of a typical project for a small dam, i.e. below the depth of 10m, is estimated at US\$284,000, for a medium dam (between 10 to 15m depth) US\$378,000.00 and US\$1,133,000.00 for a large dam.¹ Annual maintenance cost was assumed at 10% of the total investment cost. However, the actual cost depends on geographical location, soil type-sandy or rocky and distance to site.

2.4.2 Proposed Action Plans for Rain Water Collection From Ground Surfaces - Small Reservoirs and Micro-Catchments

Barrier	Root cause(s)	Proposed Measure(s)	Justification	Relevant Agency	When	Funding Sources	Indicators for Success	Possible Risks
The cost of adopting this technology is very high	The price of construction/building materials is very high	<ul style="list-style-type: none"> Promote investments in the manufacturing of building materials Accelerate investment in infrastructure such as housing Promote a access to finance by encouraging commercial banks to rely less on physical collateral when providing credit for construction 	<ul style="list-style-type: none"> To create competition & increase supply to reduce price Reduce infrastructure deficit and demand for cement in the long run. Difficult for many SMEs firms to mobilize collateral for security. Will allow construction companies arrange credit to buy cement and other materials 	<ul style="list-style-type: none"> Min of Commerce & Industry, ZAM, ZACCI, CBs, BOZ Min of Commerce & Industry, ZAM, ZACCI, CBs, BOZ BOZ, CBs, NBFIs, MOF 	<ul style="list-style-type: none"> 2014 & ongoing 2014 & ongoing From 2013 but ongoing 	<ul style="list-style-type: none"> Budgets of relevant agencies As above Budgets of relevant agencies 	<ul style="list-style-type: none"> Volume of investment in the mfg of building materials Reduced infrastructure deficit such as houses Proportion of loans given without physical collateral 	<ul style="list-style-type: none"> Difficult to regulate markets Global & domestic factors Over-regulated financial sector
	Mobilization costs are very high due to high cost of fuel	<ul style="list-style-type: none"> Streamline fuel procurement process & reduce number of taxes. --Promote transparency in oil procurement Promote use of alternative and cheaper sources of fuel 	<ul style="list-style-type: none"> Will reduce the final price paid by oil consumers Will reduce the cost of fuel 	<ul style="list-style-type: none"> Min of Com & Industry, ERB, MEWD, CBs, BOZ Min of Com & Industry, ERB, MEWD, CBs, BOZ 	<ul style="list-style-type: none"> 2014-ongoing 2014 & ongoing 	<ul style="list-style-type: none"> Budgets of relevant agencies As above 	<ul style="list-style-type: none"> Procurement of fuel is tendered to credible bidders Alternative sources of fuel promoted & used 	<ul style="list-style-type: none"> Failure by Government to adhere to tender procedure Alternative fuels not accepted by users

	Construction equipment is very expensive	<ul style="list-style-type: none"> Promote conditions for access to affordable finance for the procuring of equipment Encourage commercial banks not to use physical collateral as the only requirement when giving out loans. 	<ul style="list-style-type: none"> Efforts to bring down interests failed despite inflation falling. Now require a more interventionist interest policy SMEs face problems to arrange collateral. Other criteria e.g. sound business plan & cash flow projections should be sufficient in some cases. 	<ul style="list-style-type: none"> BOZ, CBs, NBFIs, MOF BOZ, CBs, NBFIs, MOF 	<ul style="list-style-type: none"> 2014-18 2014-18 	<ul style="list-style-type: none"> Budgets of relevant agencies Budgets of relevant agencies 	<ul style="list-style-type: none"> A policy on subsidy on excavation equipment Falling and low interest rates Loans be awarded without having physical collateral 	<ul style="list-style-type: none"> Over-regulated financial sector Difficult to regulate financial market
.Inadequate technical skills in the design and construction of dams	Culture (that rejects some skills)	<ul style="list-style-type: none"> Review current education system to change people's mindset to value every sector and job 	<ul style="list-style-type: none"> Learners and society in general has mindset that does not appreciate construction related skills 	<ul style="list-style-type: none"> Min of Education, TEVET, Trade Schools, Colleges/Universities 	<ul style="list-style-type: none"> 2014-18 	<ul style="list-style-type: none"> As above 	<ul style="list-style-type: none"> Tertiary education system reviewed 	<ul style="list-style-type: none"> Inadequate funds
		<ul style="list-style-type: none"> Introduce career guide courses at tertiary level 	<ul style="list-style-type: none"> To create a pool of career guide specialists in schools, colleges & universities 	<ul style="list-style-type: none"> Min of Education, TEVET, Colleges & Universities 	<ul style="list-style-type: none"> 2014 & ongoing 	<ul style="list-style-type: none"> Budgets of relevant agencies 	<ul style="list-style-type: none"> Career guide programs introduced 	<ul style="list-style-type: none"> Failure to implement
		<ul style="list-style-type: none"> Promote outreach programs for awareness and sensitization 	<ul style="list-style-type: none"> The need for awareness creation & sensitization is high 	<ul style="list-style-type: none"> Min of Education, TEVET, Colleges & Universities 	<ul style="list-style-type: none"> 2014 & ongoing 	<ul style="list-style-type: none"> Budgets of relevant agencies 	<ul style="list-style-type: none"> Outreach programs initiated 	<ul style="list-style-type: none"> Failure to implement due to inadequate funds
	Inadequate training facilities	<ul style="list-style-type: none"> Promote easier conditions for accessing loans – less reliance on physical collateral 	<ul style="list-style-type: none"> Training institutions face problems to arrange adequate collateral. Other criteria should be sufficient in sometimes 	<ul style="list-style-type: none"> BOZ, CBs, NBFIs, MOF 	<ul style="list-style-type: none"> 2014 & ongoing 	<ul style="list-style-type: none"> Budget of relevant agencies 	<ul style="list-style-type: none"> Loans awarded to training institutions without collateral 	<ul style="list-style-type: none"> Difficult to regulate financial markets
	High cost of training	<ul style="list-style-type: none"> Provide scholarships for skills training in dam construction 	<ul style="list-style-type: none"> Will give incentive for people to choose training in these skills 	<ul style="list-style-type: none"> MOE, TEVET, Tertiary institutions 	<ul style="list-style-type: none"> 2014 & ongoing 	<ul style="list-style-type: none"> Establish GRZ bursary for training in dam construction 	<ul style="list-style-type: none"> Number of students GRZ bursary for dam construction 	<ul style="list-style-type: none"> No funds to establish dedicated GRZ bursary

2.5 Action Plan for Boreholes/Tube Wells

2.5.1 *Target for Technology Transfer and Diffusion*

As indicated under section 1.2.2 above, the main target groups for actions on climate change adaptation in the water sector with respect to this technology of Boreholes/tube Wells for Domestic Water Supply are communities of Region I. The pilot project will target 10,000 HHs for water supply for domestic use, irrigation and animal watering.

Drilling of boreholes and tube wells will improve access to groundwater by rural populations. It will prevent reliance on poor quality alternative supplies and reduce man hours spent on travelling to far distance reliable water points. Some of the benefits of the technology include better access to water for irrigation and other uses such as watering livestock. It also increases the productivity of women as they now access water near their homes.

The costs of drilling new boreholes vary widely depending on many factors including the geological characteristics of an area. Interviews with some private suppliers indicate that a 40 to 60 metres solar powered borehole would cost between \$8,000 and \$12,000 including a 2,000 litres tank and pipes (GRZ, October 2012).^v The cost depends on geographical location, soil type-sandy or rocky and distance to site.

2.5.2 Proposed Action Plan for Boreholes/Tube Wells

Barrier	Root cause(s)	Proposed Measure(s)	Justification	Relevant Agency	When	Funding Sources	Indicators for Success	Possible Risks
Cost of drilling and installing boreholes/tube wells is very expensive	The high price of building materials (e.g. cement) due to high demand	<ul style="list-style-type: none"> Promote investments in the manufacturing of building materials Accelerate investment in infrastructure such as housing Promote a reduction in commercial bank's reliance on physical collateral when providing credit for construction) 	<ul style="list-style-type: none"> To create competition & increase supply to reduce price Reduce infrastructure deficit and demand for cement in the long run. Difficult for many SMEs firms to mobilize collateral for security. Will allow construction companies arrange credit to buy cement and other materials 	<ul style="list-style-type: none"> MCI, MOF, ZAM, ZACCI, BOZ MCI, ZAM, ZACCI, CBs, BOZ BOZ, CBs, NBFIs, MOF 	<ul style="list-style-type: none"> 2014 & ongoing 2014 & ongoing From 2013 but ongoing 	<ul style="list-style-type: none"> Budgets of relevant agencies As above Budgets of relevant agencies 	<ul style="list-style-type: none"> Investment in mfg industry for building materials Reduced infrastructure deficit such as houses Proportion of loans given without physical collateral 	<ul style="list-style-type: none"> Difficult to regulate markets Global & domestic factors Over-regulated financial sector
	The high cost of fuel that leads to high mobilization costs	<ul style="list-style-type: none"> Streamline fuel procurement process, reduce number of taxes & promote transparency Promote use of alternative and cheaper sources of fuel Introduce subsidy on fuel for Climate Change projects 	<ul style="list-style-type: none"> Will reduce the final price paid by oil consumers Will reduce the cost of fuel Need to reduce high transportation costs & import duty 	<ul style="list-style-type: none"> Min of Com & Industry, ERB, MEWD, CBs, BOZ ERB, MEWD, Research Institutions Min of Com, ERB, MEWD, CBs, BOZ 	<ul style="list-style-type: none"> 2014-ongoing 2014 & ongoing 2014 & ongoing 	<ul style="list-style-type: none"> Budgets of relevant agencies As above As above 	<ul style="list-style-type: none"> Procurement of fuel is tendered to credible bidders Alternative sources of fuel promoted & used Fuel prices and import duty reduced 	<ul style="list-style-type: none"> Failure by Government to adhere to tender procedure Alternative fuels not accepted by users Distortions in markets
	The high cost of equipment (imported heavy equipment expensive)	<ul style="list-style-type: none"> Promote conditions for ease of access to affordable finance Remove import duties on construction equipment 	<ul style="list-style-type: none"> Many contractors unable to get loans to buy equipment Will help reduce land cost of construction equipment 	<ul style="list-style-type: none"> BOZ, CBs, NBFIs, MOF, Contractors MOF, Contractors 	<ul style="list-style-type: none"> 2014-18 2014 & ongoing 	<ul style="list-style-type: none"> Budgets of relevant agencies As above 	<ul style="list-style-type: none"> # of contractors accessing loans Import duty removed or reduced 	<ul style="list-style-type: none"> Failure to convince CBs Failure to convince MOF

Some places in the country are not suitable for this type of technology	Pollution of ground water sources due to industrial effluent	<ul style="list-style-type: none"> Enforce environmental laws and other regulations Sensitize industries on environmental pollution issues 	<ul style="list-style-type: none"> There is need for stronger regulation to protection ground water sources. Lack of knowledge on environmental issues leading to 	<ul style="list-style-type: none"> Min of Environment, Min of Health, ZEMA, Min of Commerce & Industry MLENAR, MOH, ZEMA 	<ul style="list-style-type: none"> 2014 & ongoing 2014 & ongoing 	<ul style="list-style-type: none"> Budgets of relevant agencies As above 	<ul style="list-style-type: none"> Penalties & regulations for polluters are revised & enforced Number of sensitization meetings held 	<ul style="list-style-type: none"> Lack of funds Implementation by the judiciary Failure to implement
	Wrongly sited activities due to inadequate use of Land Use Plans leading to ground water pollution	<ul style="list-style-type: none"> Promote the development and enforcement of Land Use Plans as a management tool 	<ul style="list-style-type: none"> Lack of land use plans has led to unplanned settlements & developments 	<ul style="list-style-type: none"> MLENAR MLGH 	<ul style="list-style-type: none"> 2014 & ongoing 	<ul style="list-style-type: none"> Budgets of relevant agencies 	<ul style="list-style-type: none"> Reduced unplanned settlements & developments 	<ul style="list-style-type: none"> Failure to enforce plans
	Indiscriminate use of agricultural chemicals leading to ground water contamination	<ul style="list-style-type: none"> Promote effective regulation of the use of agricultural chemicals Increase awareness on use of agricultural chemical to farmers 	<ul style="list-style-type: none"> Indiscriminate use of chemicals leading to contamination of underground and surface water sources As above 	<ul style="list-style-type: none"> Min of Agriculture, ZNFU, ZEMA Min of Agriculture, ZNFU, ZEMA 	<ul style="list-style-type: none"> 2014 & ongoing 2014 & ongoing 	<ul style="list-style-type: none"> As above Budgets of relevant agencies 	<ul style="list-style-type: none"> License & monitor all agriculture chemicals outlets Number of sensitization meetings held 	<ul style="list-style-type: none"> Difficult to regulate markets Failure to implement due to lack of funds
	Unsustainable farming Methods leading to ground water depletion	<ul style="list-style-type: none"> Promote sustainable farming methods such as conservation farming practices 	<ul style="list-style-type: none"> Poor farming methods leading to depletion of underground 	<ul style="list-style-type: none"> Min of Agriculture, ZNFU, CFU 	<ul style="list-style-type: none"> 2014 & ongoing 	<ul style="list-style-type: none"> Budgets of relevant agencies 	<ul style="list-style-type: none"> Number of farmers practicing conservation farming 	<ul style="list-style-type: none"> Difficult to enforce the practice as it not law

Inadequate technical skills in the design and construction of dams	Culture (that rejects some skills)	<ul style="list-style-type: none"> Review current education system to change people's mindset to value every sector and job 	<ul style="list-style-type: none"> Learners and society in general has mindset that does not appreciate construction related skills 	<ul style="list-style-type: none"> Min of Education, TEVET, Trade Schools, Colleges/Universities 	<ul style="list-style-type: none"> 2014-18 	<ul style="list-style-type: none"> As above 	<ul style="list-style-type: none"> Tertiary education system reviewed 	<ul style="list-style-type: none"> Inadequate funds
		<ul style="list-style-type: none"> Introduce career guide courses at tertiary level 	<ul style="list-style-type: none"> To create a pool of career guide specialists in schools, colleges & universities 	<ul style="list-style-type: none"> Min of Education, TEVET, Colleges & Universities 	<ul style="list-style-type: none"> 2014 & ongoing 	<ul style="list-style-type: none"> Budgets of relevant agencies 	<ul style="list-style-type: none"> Career guide programs introduced 	<ul style="list-style-type: none"> Failure to implement
		<ul style="list-style-type: none"> Promote outreach programs for awareness and sensitization 	<ul style="list-style-type: none"> The need for awareness creation & sensitization is high 	<ul style="list-style-type: none"> Min of Education, TEVET, Colleges & Universities 	<ul style="list-style-type: none"> 2014 & ongoing 	<ul style="list-style-type: none"> Budgets of relevant agencies 	<ul style="list-style-type: none"> Outreach programs initiated 	<ul style="list-style-type: none"> Failure to implement due to inadequate funds
	Inadequate training facilities	<ul style="list-style-type: none"> Promote easier conditions for accessing loans – less reliance on physical collateral 	<ul style="list-style-type: none"> Training institutions face problems to arrange adequate collateral. Other criteria should be sufficient in sometimes 	<ul style="list-style-type: none"> BOZ, CBs, NBFIs, MOF 	<ul style="list-style-type: none"> 2014 & ongoing 	<ul style="list-style-type: none"> Budget of relevant agencies 	<ul style="list-style-type: none"> Loans awarded to training institutions without collateral 	<ul style="list-style-type: none"> Difficult to regulate financial markets
High cost of training	<ul style="list-style-type: none"> Provide scholarships for skills training in dam construction 	<ul style="list-style-type: none"> Will give incentive for people to choose training in these skills 	<ul style="list-style-type: none"> MOE, TEVET, Tertiary institutions 	<ul style="list-style-type: none"> 2014 & ongoing 	<ul style="list-style-type: none"> Establish GRZ bursary for training in dam construction 	<ul style="list-style-type: none"> Number of students GRZ bursary for dam construction 	<ul style="list-style-type: none"> No funds to establish GRZ bursary 	

2.6 Action Plan for Building of a Concrete Apron/Collar on the Well

2.6.1 *Target for Technology Transfer and Diffusion*

The main target groups for actions on climate change adaptation with respect to this technology are communities in Region I. The pilot project will target 2,000 HHs who are affected by the seasonal floods that brings up the challenge of accessing clean water.

The technology will reduce the chances of households failing to access potable safe water supplies during floods. It will reduce the time lost traveling long distances to access good drinking water when the water point gets either damaged, contaminated or cannot be accessed because of the floods. Avoiding such loss of time prevents disruption in productive activities and the negative implications this entails. Time loss to morbidity or taking care of a sick relative especially by women due to water borne disease from contaminated water points is also reduced.

The estimated unit cost of protected well built to be resilient to flooding is US\$4,000. The cost depends on geographical location, soil type-sandy or rocky and distance to site.

2.6.2 Proposed Action Plan for Building of a Concrete Apron/Collar on the Well

Barrier	Root cause(s)	Proposed Measure(s)	Justification	Relevant Agency	When	Funding Sources	Indicators for Success	Possible Risks
The high cost of materials for use to improve the wells	The high price of building materials (e.g. cement) due to high demand	<ul style="list-style-type: none"> Promote investments in the manufacturing of building materials Accelerate investment in infrastructure such as housing Promote a reduction in commercial bank's reliance on physical collateral when providing credit for construction) 	<ul style="list-style-type: none"> To create competition & increase supply to reduce price Reduce infrastructure deficit and demand for cement in the long run. Difficult for many SMEs firms to mobilize collateral for security. Will allow construction companies arrange credit to buy cement and other materials 	<ul style="list-style-type: none"> ZDA, MOF, ZAM, ZACCI, BOZ ZDA, ZAM, ZACCI, CBs, BOZ BOZ, CBs 	<ul style="list-style-type: none"> 2014 & ongoing 2014 & ongoing From 2013 but ongoing 	<ul style="list-style-type: none"> Budgets of relevant agencies As above Budgets of relevant agencies 	<ul style="list-style-type: none"> Investment in mfg industry for building materials Infrastructure constructed % of loans given without physical collateral 	<ul style="list-style-type: none"> Difficult to regulate markets Global & domestic factors Over-regulated financial sector
	The high cost of fuel that leads to high mobilization costs	<ul style="list-style-type: none"> Streamline fuel procurement process, reduce number of taxes & promote transparency Promote use of alternative and cheaper sources of fuel Introduce subsidy on fuel for Climate Change projects 	<ul style="list-style-type: none"> Will reduce the final price paid by oil consumers Will reduce the cost of fuel Need to reduce high transportation costs & import duty 	<ul style="list-style-type: none"> Min of Com & Industry, ERB, MEWD, CBs, BOZ ERB, MEWD, Research Institutions Min of Com & Industry, ERB, MEWD, CBs, BOZ 	<ul style="list-style-type: none"> 2014-ongoing 2014 & ongoing 2014 & ongoing 	<ul style="list-style-type: none"> Budgets of relevant agencies As above As above 	<ul style="list-style-type: none"> Procurement of fuel is tendered to credible bidders Alternative sources of fuel promoted & used Fuel prices and import duty reduced 	<ul style="list-style-type: none"> Failure by Government to adhere to tender procedure Alternative fuels not accepted by users Distortions in markets

Barrier	Root cause(s)	Proposed Measure(s)	Justification	Relevant Agency	When	Funding Sources	Indicators for Success	Possible Risks
Inadequate information & knowledge by intended users on the technology	Inadequate Sensitization Campaigns	<ul style="list-style-type: none"> Re-employ extension personnel for awareness creation and sensitization programs 	<ul style="list-style-type: none"> Effective way of imparting information and awareness 	<ul style="list-style-type: none"> Min of Local Government, Min of Community Development 	<ul style="list-style-type: none"> 2014 & ongoing 	<ul style="list-style-type: none"> Budgets of relevant agencies 	<ul style="list-style-type: none"> Number of extensions officers 	<ul style="list-style-type: none"> Failure to implement due to inadequate funds
	Inadequate platforms for knowledge & information sharing	<ul style="list-style-type: none"> Creation of more forums for inter-departmental knowledge & information sharing on water, sanitation and hygiene Support existing platforms for program implementation such as D-WASHes Identify specific institutions to undertake sensitizations programs on knowledge & information sharing 	<ul style="list-style-type: none"> Need for more coordination & collaboration for agreeing on a shared agenda Strengthening & using already existing structures most cost effective Better results could be expected from using institutions with recognized capacity already 	<ul style="list-style-type: none"> Min of Health, Min of Community Development, ZEMA, NWASCO, Min of Local Govt Min of Health, Min of Community Development, ZEMA, NWASCO, Min of Local Govt Min of Health, Min of Community Development, ZEMA, NWASCO, Min of Local Govt 	<ul style="list-style-type: none"> 2014-18 2014-18 2014-18 	<ul style="list-style-type: none"> Budgets of relevant agencies As above Budgets of relevant agencies 	<ul style="list-style-type: none"> More dialogue platforms established Frequency in meetings by existing platforms Number of sensitization meetings held/Number of institutions doing sensitization 	<ul style="list-style-type: none"> Difficult to regulate them actors that have weakened existing platforms continue Failure to implement due to inadequate funds

3. Technology Action Plan for Agriculture and Food Security Sector

3.1 Objectives and Preliminary Targets for Diffusion of Adaptation

In the agriculture and food security sector, the following three technologies were prioritized at the TNA stage:

- 1 Conservation Farming With Agro-forestry
- 2 Integrated Farming Systems
- 3 Crop Diversification and New Varieties

Zambia's agriculture is considered as offering the greatest potential for broad based growth based on its potential, contribution to GDP and the fact that the vast majority of Zambia's labour force is in agriculture. The sector, however, faces many challenges that undermine its ability to fulfill its potential to contribute to economic development. Climate change negative effects such as droughts, floods, extreme temperature, shorter rain seasons and increasing variability in rainfall during the rainy season have further complicated the situation in the recent past. Small scale farmers who are the vast majority of farmers in the country are the most vulnerable these negative effects. In terms of regions, Agro-ecological Region I has been the most vulnerable to climate change.

The diffusion of the prioritized adaptation technologies is meant to help address some of these concerns by improving small farmers' resilience to the adverse effects of climate change. It is proposed to establish a Pilot Smallholder Climate Change Resilience (PSCCR) Project to provide an implementation framework. Table 2 is a bird's eye view of the preliminary targets for the proposed pilot project. Although this is a separate project from the Pilot Project on Climate Change and Water Access, synergies could be drawn from the two projects to ensure maximum impact given that they will cover the same region.

Table 2: Preliminary Targets for the Pilot Smallholder Climate Change Resilience and Adaptation Project

Technology	Number of HH	Cost Per HHs (US\$)	Total Direct Costs	Project Admin Cost (15%)	Total Cost
Conservation farming	3,000	943	2,829,000	424,350	3,253,350
Integrated small livestock-fish-poultry-vegetable production system	500	1,938	969,000	145,350	1,114,350
Promotion of drought-tolerant and early maturing food crops (cassava).	3,000	300	900,000	135,000	1,035,000
Total	6,500		4,698,000	704,700	5,402,700

The PSCCR project will have the following specific objectives:

1. Enable farmers in Agro-ecological Region I achieve higher yields with less water and less chemicals while conserving soil fertility;
2. Help farmers build crop resilience to diseases, pest organisms and environmental stresses; and,

3. Enable farmers spread the risk widely by diversifying their enterprises while in the process making their farming systems more profitable

The targets in Table 2 could be further explained as:

- *Conservation farming with Musangu Tree:* The pilot project will target 3,000 agricultural HHs in Region I who will each be helped to get 100 trees to be planted on a 1 hectare plot of land.
- *Integrated Production Systems:* 500 agricultural HHs will be targeted and each helped to acquire fingerlings, livestock (5 goats & 10 ducks), sorghum and sugar beans and vegetable seeds sufficient for a 1.25 Ha plot of land.
- *Promotion of drought and early maturing varieties:* 3,000 agricultural HHs will be helped to get drought and early maturing seed varieties of cassava and sorghum.

3.2 Brief Description of Adaptation Technologies in the Agriculture and Food Security Sector

A brief description of the three priority technology options and the specific technologies arising from them are provided below.

3.2.1 Conservation Farming

Conservation farming refers to a number of practices that in combination conserve soil, moisture, fertilizer, seeds, energy and time. Basic features include no burning of crop residues, correctly spaced planting basins established before the rains, early planting of all crops, early weeding and rotation with a minimum of 30% legumes in the system. The specific type of technology identified was conservation farming with agro-forestry with either *faidherbia albida*, *trephrosia vogellii*, *sesbania sesban* or *glicicidia sepium*.

3.2.2 Integrated Farming

Integrated farming is a form of mixed farming, an agricultural system in which a farmer conducts different agricultural practices together such as production of cash crops and livestock. Mixed farming is practiced widely in Zambia and there is a very wide range of combinations in which this could occur. However, for the TNA process, an integrated farming system of livestock-poultry-fish-vegetables which is yet to take hold among small and medium farmers in Zambia was proposed for consideration. Specifically further, the proposal is for an integrated farming system of non-ruminants (village chickens and ducks), pigs, goats, fish farming and vegetables.

3.2.3 Crop Diversification and New Varieties

This is the addition of new crops or cropping systems to agricultural production on a particular farm taking into account the different returns from value-added crops with complementary marketing opportunities. It addresses climate change related risks farmers dependent on rain-fed agriculture face from planting long maturing varieties. Specifically this is the promotion of new varieties for Zambia's major staple crops of sorghum, millet, cassava, sweet potatoes and maize.

3.3 General Barriers and Proposed Measures

The barriers and proposed measures in the Agriculture and Food Security sector were identified and categorized into two as in the case of the water sector.

3.3.1 *Economic and Financial Barriers and Measures*

The high cost of the technology was a common financial barrier with respect to the diffusion of integrated farming and crop diversification using new varieties. The total cost of investing in integrated farming on 1.2 ha land was estimated US\$2,773 which is very high for poor small and medium farmers. The capital investment costs include among others; purchase of new seed varieties, labour time, on-farm equipment and infrastructure development such as fish ponds and buildings to house livestock. In the case of crop diversification, coming up with new varieties is expensive to which is added the promotion costs so that farmers accept the new varieties. Apart from the difficulty to initiate and sustain the development of improved seed, the high price of such seed which results is a big deterrence to adoption by the small farmers.

The process of developing suitable seed varieties from research to marketing is expensive and will always make hybrid seed more expensive. Seed producers need to be encouraged to use cheaper methods of seed production such as the 2-way approach. Public policy could help reduce somewhat the price of hybrid seed through better support than is currently the case. One way is to make seed multiplication by small farmers in rural communities a beneficiary of the FISP which is currently focused only on maize production. This will also help to make such seed more accessible as it will be produced in the very areas farmers are.

Reduction or removal of import duty on basic agricultural implements necessary in integrated farming will go a long way in making the technology accessible. The government can also create an enabling environment for the private sector to play a more supportive role of providing start-up capital to small scale farmers. The concept of out-grower schemes will address some of the barriers on costs. Funding was required for initiatives aimed at increasing the flow of information to farmers on farming practice by funding translation of materials into easy-to-read and user-friendly formats and coordinating the flow of information.

3.3.2 *Non Financial Barriers and Measures*

The labour intensity of proposed technologies was a key barrier given the labour shortages in most households. This was particularly the case with integrated farming. The high cost of hired labour compounds the challenge as most small scale and medium scale farmers cannot afford to do so. Inadequate information and inadequate access to improved varieties affected both integrated farming and crop diversification. Inadequate information was mainly due to the inappropriate restructuring of the Ministry of Agriculture and Livestock which saw the abolition of the Research and Extension Liaison Officer (RELO) position while the research branch and extension branch which had hitherto been under one directorate were elevated to directorates and now existed in parallel with no effective coordination. It all led to inadequate linkage between research and extension. Fragmented structures do not reach at the community level for effective and holistic outreach to farmers on integrated farming. Inadequate access to improved

varieties is partially a result of the relatively high cost for farmers and inadequate information but is also due to the low multiplication of the varieties by seed companies preferring instead to focus on maize given the low demand for other crops.

In view of the weak linkages between extension and research, there is need for creating a position like the one occupied by the RELO. This should be facilitated by the Cabinet Office. It will enhance coordination of information dissemination across the departments responsible for crops, livestock and fisheries development. This position should also have a presence at provincial level where the dissemination of agricultural information should be coordinated to ensure that farmers and fishers receive timely information regarding agricultural technologies suitable to adapt to climate change. Institutional strengthening should involve the strengthening professional bodies for their advisory role and the Agriculture Sector Advisory Group as a forum for better coordinated strategies.

Other non-financial measures included adoption of effective communication strategies by using cost effective communication channels and ensuring that information dissemination was participatory. Further, there should be a refocus on research in agro-forestry to come up with tree species that had more favourable traits for better farmer adoption. Farmers should be encouraged by the promoters of integrated farming to take up the practice at the scale they could manage and upscale gradually. Promotion of farm power mechanization was the other measure to counter labour scarcity. The Seed Certification Council Institute needed to be strengthened to provide a strong regulatory framework in which regulations on seed are enforced. There was need to work on the demand side by popularizing the consumption of traditional crops as well as facilitating exports of the same to regional and international markets. The supply side issues could be resolved apart from the introduction of subsidies by encouraging seed producers to find cheaper ways of coming up and producing seed varieties.

The cost of labour in rural areas of Zambia has been escalating over the years due to inadequate manpower at household level. This has mainly been caused by the high rural-urban migration of productive young people. Measures to reverse the high rural-urban migration should be promoted. One of these is to promote agriculture as a viable business that provides young people meaningful employment in rural areas. A cultural mindset shift to change the way agriculture is viewed should thus be promoted. This should be accompanied by measures that make agricultural production a lucrative business by ensuring that agriculture markets work for small farmers.

3.4 Action Plan for Conservation Farming With Agro-forestry

3.4.1 General Description

Conservation farming is well known and practiced by a number of small and medium scale farmers in Zambia. The main promoters have been the Conservation Farming Unit, the Ministry of Agriculture and Livestock Development, the Golden Valley Agricultural Research Trust (GART), the Zambia Agricultural Research Institute (ZARI) and some non-governmental organizations.

There are many environmental benefits of conservation farming with agro-forestry. The preservation of soil fertility is the most obvious. Besides this, conservation farming with agro-forestry helps minimizing soil erosion, growth of micro-organisms and reduction of the use of herbicides and fertilizers. The main

objective of this technology is to fertilize the field where food crops like maize are intercropped. There are numerous benefits that are attributed to this farming practice. These include: enhanced food crop yield as a result of intercropping with nitrogen-fixing trees. Organic matter, nitrogen and other nutrients are added to the soil as a result of the falling leaves and seed pods. The leaves and seed pods are also used as protein-rich livestock fodder, the tree bark as a medicine and the wood for construction.

3.4.2 Target for Technology Transfer and Diffusion

The main target groups in the agriculture and food security sector are small farmers in Agro-ecological Region I. As already noted, Region I is extremely vulnerable to climate change and at the same time, the agriculture sector is one of the most vulnerable sectors to climate change hazards. These two aspects put together make it highly necessary that interventions to address the consequences be initiated in this region in the agriculture sector.

The pilot project for conservation farming with agro-forestry will target 3,000 farm households in Region I. They will each be supplied with 100 agro-forestry trees to be planted on a 1 hectare plot of land. The unit cost of agro-forestry seedlings is ZMK5000 (\$0.93). A total of 100 trees are required for 1 hectare piece of land. A total of ZMK5,000,000 (\$943) would be an investment cost for a small scale farmer with 1 hectare piece of land in Zambia. Therefore, the estimated cost for the 3,000 agricultural households will be \$2,829,000 or \$3,253,350 once

3.4.3 Proposed Action Plan for Conservation Farming With Agro-Forestry

Barrier	Root cause(s)	Proposed Measure(s)	Justification	Relevant Agency	When	Funding Sources	Indicators for Success	Possible Risks
Inadequate Information on conservation farming with agro-forestry	Ineffective communication strategies	<ul style="list-style-type: none"> Devise grassroots anchored and cost effective communication strategies, e.g. farmer field schools, radio listening groups etc Promote farmer-led communication programs Strengthen cooperatives to work as information centers 	<ul style="list-style-type: none"> These already exist and would be more cost effective to use rather than setting up new channels Will allow farmers impart relevant knowledge, experiences & lessons among themselves Many cooperatives created since 2001 and are currently underutilized as they focus mostly on FSIP 	<ul style="list-style-type: none"> Min of Agriculture, Min of Education, Min of Community Development, NAIS, ZNFU Min of Agriculture, Min of Education, Min of Community Development, NAIS, ZNFU Min of Agriculture, Min of Education, Min of Community Development, NAIS, ZNFU 	<ul style="list-style-type: none"> From 2014 but Ongoing – 2013 & Ongoing • 2014 & Ongoing 	<ul style="list-style-type: none"> Budgets of relevant agencies – As above Budgets of relevant agencies 	<ul style="list-style-type: none"> Number of radio programs, sensitization meetings and farmer field trips Number of workshops/ farmer field trips held Number of cooperative acting as information centres 	<ul style="list-style-type: none"> Lack of funds Lack of funds Farmers may lack motivation to use information centers
	Scarcity of farmer literature in local languages	<ul style="list-style-type: none"> Provide funds to translate materials into easy-to-read and user-friendly format Help NAIS employ skilled manpower to translate agricultural information packages 	<ul style="list-style-type: none"> Important to have literature available in the language they understand Will eventually provide a pool of skilled and knowledgeable translators 	<ul style="list-style-type: none"> Min of Agriculture, Min of Education, ZNFU Min of Agriculture, Min of Education, ZNFU 	<ul style="list-style-type: none"> 2014 & Ongoing 2014 & Ongoing 	<ul style="list-style-type: none"> Budgets of relevant agencies As above 	<ul style="list-style-type: none"> User friendly materials available Agricultural information translated and packaged 	<ul style="list-style-type: none"> Lack of funds for translation, printing & distribution As above

	Lack of linkages between research and extension	<ul style="list-style-type: none"> Re-establish the position of RELO 	<ul style="list-style-type: none"> Needed to strengthen research-extension linkage 	<ul style="list-style-type: none"> Min of Agriculture, Min of Finance, Cabinet Office 	<ul style="list-style-type: none"> 2014 & Ongoing 	<ul style="list-style-type: none"> Budgets of relevant agencies 	<ul style="list-style-type: none"> Sensitization and awareness creation meetings 	<ul style="list-style-type: none"> Failure by Government to implement proposal
	Uncoordinated information flow	<ul style="list-style-type: none"> Raise effectiveness of SAGs as coordinating bodies Strengthen professional bodies to play advisory role 	<ul style="list-style-type: none"> SAGs already existing to facilitate consultation. Need strengthening Can play critical role in evidence based policy analysis 	<ul style="list-style-type: none"> Min of Agriculture, All SAG members professional bodies As above 	<ul style="list-style-type: none"> 2014 & Ongoing 2014 & Ongoing 	<ul style="list-style-type: none"> Budgets of relevant agencies As above 	<ul style="list-style-type: none"> Regularity of Agric SAG meetings Number of policy research and analysis outputs 	<ul style="list-style-type: none"> Common SAG problems continue Low demand for evidence based policy research
Does not produce immediate benefits	Long maturity period	<ul style="list-style-type: none"> Promote research leading to development of trees with desired traits such as early maturing and ability to produce large biomass 	<ul style="list-style-type: none"> Necessary to produce varieties that would bring quick results to farmers if agro-forestry is to be extensively adopted 	<ul style="list-style-type: none"> ZARI, GART, CFU, MALD, 	<ul style="list-style-type: none"> 2014 & ongoing 	<ul style="list-style-type: none"> Budgets of relevant agencies 	<ul style="list-style-type: none"> Research budget dedicated to development of agro-forestry varieties 	<ul style="list-style-type: none"> Low research budget
Species may not grow in some regions	Some Species Are Not Adapted	<ul style="list-style-type: none"> Promote research leading to development of trees with desired traits such as ability to grow in all the regions of the country 	<ul style="list-style-type: none"> Necessary to produce varieties that could be grown widely in the country for agro-forestry to be extensively adopted 	<ul style="list-style-type: none"> ZARI, GART, CFU, MALD, 	<ul style="list-style-type: none"> 2014 & ongoing 	<ul style="list-style-type: none"> Budgets of relevant agencies 	<ul style="list-style-type: none"> Research budget dedicated to development of agro-forestry varieties 	<ul style="list-style-type: none"> Low research budget

3.5 Action Plan for Integrated Farming Systems

3.5.1 *General Description*

Integrated farming of small livestock-fish-poultry-vegetable-crop production system operates on the premise of inter-dependency. Crop production depends on the supply of animal manure. Livestock plays a key role fertilizing the fish pond and field crops. The small livestock depends on extensive grazing of natural pasture and crop residues during the dry season. This is a closed system in which waste products from one activity are used as input in the other activity. For example, the waste products from crops and vegetables are used by livestock and fish.

The main climate change benefit of mixed farming in general and integrated farming in particular is that farmers have chance to spread their risks across several enterprises. The effects of failure of one enterprise as a result of climate change hazards is somewhat mitigated by the other enterprises that continue to operate. And yet at the same time, the interdependence of enterprises makes them more resilient to climate change hazards.

The total investment cost for integrated crop-small livestock-fish-poultry-vegetable production system was estimated at ZMK 15,226,900 (\$ 2,873).

3.5.2 *Target for Technology Transfer and Diffusion*

The preliminary targets for Integrated Production Systems pilot project will target 50 agricultural HHs who will each be helped to acquire fingerlings, livestock (5 goats & 10 ducks), sorghum and sugar beans and vegetable seeds sufficient for a 1.25 Ha plot of land.

3.5.3 Proposed Action Plan for Integrated Farming (IF) System

Barrier	Root cause(s)	Proposed Measure(s)	Justification	Relevant Agency	When	Funding Sources	Indicators for Success	Possible Risks
Little knowledge of how to move from simple mixed farming to integrated farming	Inadequate information on integrated production systems	<ul style="list-style-type: none"> Devise communication channels which are cost-effective, e.g. community schools, farmer field schools, radio listening groups etc 	<ul style="list-style-type: none"> These already exist and would be more cost effective to use rather than setting up new channels 	<ul style="list-style-type: none"> Min of Agriculture, Min of Education, Min of Community Development, NAIS, ZNFU 	<ul style="list-style-type: none"> From 2014 but Ongoing 	<ul style="list-style-type: none"> Budgets of relevant agencies 	<ul style="list-style-type: none"> Number of radio programs, sensitization meetings and farmer field trips 	<ul style="list-style-type: none"> Lack of funds
		<ul style="list-style-type: none"> Promote farmer-led communication programs 	<ul style="list-style-type: none"> Will allow farmers impart relevant knowledge, experiences & lessons among themselves 	<ul style="list-style-type: none"> Min of Agriculture, Min of Education, Min of Community Development, NAIS, ZNFU 	<ul style="list-style-type: none"> 2013 & Ongoing 	<ul style="list-style-type: none"> As above 	<ul style="list-style-type: none"> Number of workshops/ farmer field trips held 	<ul style="list-style-type: none"> Lack of funds
		<ul style="list-style-type: none"> Strengthen cooperatives to work as information centers 	<ul style="list-style-type: none"> Many cooperatives created since 2001 and are currently underutilized as they focus mostly on FSIP 	<ul style="list-style-type: none"> Min of Agriculture, Min of Education, Min of Community Development, NAIS, ZNFU 	<ul style="list-style-type: none"> 2014 & Ongoing 	<ul style="list-style-type: none"> Budgets of relevant agencies 	<ul style="list-style-type: none"> Number of cooperative acting as information centres 	<ul style="list-style-type: none"> Farmers may lack motivation to use information centers
High start-up cost of investing in integrated production system	High input requirements	<ul style="list-style-type: none"> Encourage farmers to adopt IF through a phased approach 	<ul style="list-style-type: none"> Will allow farmers to raise funds from one enterprise to add another enterprise 	<ul style="list-style-type: none"> Min of Agric, ZNFU, NAIS 	<ul style="list-style-type: none"> 2014 & Ongoing 	<ul style="list-style-type: none"> Budgets of relevant agencies 	<ul style="list-style-type: none"> Change in types of enterprises per farmers 	<ul style="list-style-type: none"> Inadequate funds to promote IF
		<ul style="list-style-type: none"> Encourage farmers to adopt integrated farming at lower scale and expand slowly 	<ul style="list-style-type: none"> With raised resources, farmers would be more able to handle bigger operations 	<ul style="list-style-type: none"> Min of Agric, ZNFU, NAIS 	<ul style="list-style-type: none"> 2014 & Ongoing 	<ul style="list-style-type: none"> Budgets of relevant agencies 	<ul style="list-style-type: none"> Average growth in IF 	<ul style="list-style-type: none"> Inadequate funds to promote IF
		<ul style="list-style-type: none"> Promote practice of agriculture sector as a business and make it attractive for lending 	<ul style="list-style-type: none"> A business approach to farming will enable farmers to borrow for investing in integrated farming 	<ul style="list-style-type: none"> Min of Agric, ZNFU, NAIS 	<ul style="list-style-type: none"> 2014 & Ongoing 	<ul style="list-style-type: none"> Budgets of relevant agencies 	<ul style="list-style-type: none"> % of farmers observing farming as a business practices 	<ul style="list-style-type: none"> Inadequate funds to promote farming as a business

Barrier	Root cause(s)	Proposed Measure(s)	Justification	Relevant Agency	When	Funding Sources	Indicators for Success	Possible Risks
Inadequate manpower at household level	Labour Intensive	<ul style="list-style-type: none"> Promote integrated farming at scales of production that are manageable to farmers 	<ul style="list-style-type: none"> Potential for take up only realizable if production system feasible for farmers 	<ul style="list-style-type: none"> Min of Agriculture, CBs, BOZ 	<ul style="list-style-type: none"> 2014 & Ongoing 	<ul style="list-style-type: none"> Budgets of relevant agencies 	<ul style="list-style-type: none"> Number of farmers successfully practicing integrated farming 	<ul style="list-style-type: none"> Failure to increase manpower due to lack of funds
		<ul style="list-style-type: none"> Promote farm power mechanization Promote integrated farming at scales of production that can be managed by farmers in view of labour constraints 	<ul style="list-style-type: none"> To relieve labour constraints at household level 	<ul style="list-style-type: none"> Min of Agriculture, CBs, BOZ 	<ul style="list-style-type: none"> 2014 & Ongoing 	<ul style="list-style-type: none"> Budgets of relevant agencies 	<ul style="list-style-type: none"> Number of farmers taking up farm power mechanization 	<ul style="list-style-type: none"> Low capacity farmers to acquire equipment

3.6 Action Plan for Promotion of Drought and Early Maturing Crop Varieties

3.6.1 General Description

Promotion of drought-tolerant and early maturing food crop varieties helps to reduce the risk of crop loss and enhance crop resilience to disease and harsh climatic conditions. Drought-tolerant and early maturing crop varieties have varied benefits. However, drought-tolerant and early maturing crop varieties are not without difficulty when promoting them. The main benefit of this adaptation option is that it allows farmers to plant crops that demonstrate the qualities of early maturity, resilience to disease and greater nutritional value.

3.6.2 Target for Technology Transfer and Diffusion

The preliminary targets for the promotion of drought and early maturing crop varieties project in Table 2 is 3,000 agricultural households in Agro-ecological Region I. Each will be helped to access drought and early maturing seed varieties of cassava and sorghum. The total investment cost of cultivation of improved cassava variety using hand hoes on 1 ha plot of land is US \$ 151.

3.6.3 General Barriers and Measures

Of the barriers listed the relatively high cost of improved varieties in general was the only economic/financial barrier. This was due to the high cost of research and breeding new varieties. Non-financial barriers included the lack of information and inadequate access to improved varieties of crops like cassava, sorghum and millet. The reason for this is as in the other two technologies, i.e. the inappropriate restructuring of the Ministry of Agriculture and Livestock² which saw the abolition of the RELO position. The other was inadequate access to improved varieties apart from the relatively high cost to farmers of hybrid seed and inadequate information on new varieties and crop diversification, was also due to the low multiplication of the varieties by seed companies preferring instead to focus on maize.

In order to address the barriers identified under this technology, the enabling framework require promoting and implementing policies that will:

1. Secure funds for initiatives aimed at increasing flow of information to farmers on farming practices through translation of materials into easy-to-read and user-friendly formats and better coordination of the flow of information.
2. Lead to public policy that tackles the high price of improved seed including special subsidies for seed multiplication such as by small farmers in rural communities.
3. Institutional strengthening in the Ministry of Agriculture and Livestock so that there is better coordination of information between research and extension.
4. Strengthen the regulatory framework of seed production and marketing to maintain the credibility of the seed industry protecting both users and producers.

3.6.4 Action Plan for Promotion of Crop Diversification and New Varieties

Barrier	Root cause(s)	Proposed Measure(s)	Justification	Relevant Agency	When	Funding Sources	Indicators for Success	Possible Risks
Low farmer confidence in improved seed	Inadequate enforcement of regulation	<ul style="list-style-type: none"> Give the Seed Certification Council Institute (SCCI) powers to prosecute offenders Have more staff at SCCI to enforce regulations 	<ul style="list-style-type: none"> To ensure that seed sellers are selling genuine seed and retain confidence in improved seed To ensure that seed sellers are selling genuine seed 	<ul style="list-style-type: none"> Min of Agric. ZNFU, SCCI, Min of Justice Min of Agriculture, ZNFU, SCCI 	<ul style="list-style-type: none"> From 2014 & Ongoing 2014 & Ongoing 	<ul style="list-style-type: none"> Budgets of relevant agencies As above 	<ul style="list-style-type: none"> Number of prosecutions of offenders Staffing levels at the SCCI 	<ul style="list-style-type: none"> Lack of actions due to bureaucracy Inadequate funds to implement proposal
		<ul style="list-style-type: none"> Intensive and sustained awareness programs on quality seed 	<ul style="list-style-type: none"> For awareness creation & sensitization 	<ul style="list-style-type: none"> Min of Agriculture, ZNFU, NAIS, SCCI 	<ul style="list-style-type: none"> 2014 & Ongoing 	<ul style="list-style-type: none"> As above 	<ul style="list-style-type: none"> Number of farmers receiving agric information through established channels 	<ul style="list-style-type: none"> Lack of funds
Inadequate accessibility to improved seed by farmers	Low number of outlets supplying improved seed	<ul style="list-style-type: none"> Capacity building initiatives along the seed value chain 	<ul style="list-style-type: none"> Will provide strong linkages in seed value chain from production to supply outlets 	<ul style="list-style-type: none"> Min of Agriculture, ZNFU 	<ul style="list-style-type: none"> 2014 & Ongoing 	<ul style="list-style-type: none"> As Above 	<ul style="list-style-type: none"> Number of new outlets selling genuine seed 	<ul style="list-style-type: none"> Difficult to regulate the market
	Inadequate markets for hybrid seed	<ul style="list-style-type: none"> Promote value addition and consumption of traditional crops and raise demand for hybrid seed Promote export of traditional crops to regional and international markets 	<ul style="list-style-type: none"> There is need to raise the consumption and demand of traditional crops if demand for hybrid seed would rise To raise the demand for traditional crops 	<ul style="list-style-type: none"> Min of Agriculture, GART Min of Agriculture, Min of Commerce, GART 	<ul style="list-style-type: none"> 2014 & Ongoing 2014 & Ongoing 	<ul style="list-style-type: none"> As above Budgets of relevant agencies 	<ul style="list-style-type: none"> Traditional crops are popularized and consumed Value of exports of traditional crops 	<ul style="list-style-type: none"> Changing tastes a long term outcome Low trade related capacity

Barrier	Root cause(s)	Proposed Measure(s)	Justification	Relevant Agency	When	Funding Sources	Indicators for Success	Possible Risks
Inadequate accessibility to improved seed by farmers	Poor storage facilities in remote areas	<ul style="list-style-type: none"> Provide storage facilities across the country 	<ul style="list-style-type: none"> To enhance seed safety 	<ul style="list-style-type: none"> Min of Agriculture, ZNFU 	<ul style="list-style-type: none"> 2014 & ongoing 	<ul style="list-style-type: none"> Budgets of relevant agencies As above 	<ul style="list-style-type: none"> Number of storage facilities established 	<ul style="list-style-type: none"> Inadequate funds
	High price of hybrid seed	<ul style="list-style-type: none"> Build capacity and devise incentives for cottage seed production so hybrid seed can be produced within their communities Encourage seed companies to use cheaper methods such as the 2-way cross method 	<ul style="list-style-type: none"> To have hybrid seed produced within communities and make it cheaper to farmers To make seed cheaper 	<ul style="list-style-type: none"> Min of Agriculture, MOF Min of Agriculture, seed companies 	<ul style="list-style-type: none"> 2014 & Ongoing 2014 & Ongoing 	<ul style="list-style-type: none"> Budgets of relevant agencies As above 	<ul style="list-style-type: none"> Seed production subsidized under FISP Reduction in the price of seed paid by farmers 	<ul style="list-style-type: none"> Difficult to regulate markets Seed companies do not pass on cost reduction to farmers
		<ul style="list-style-type: none"> Encourage seed companies to introduce accelerated seed development like double haploid technique which takes 3 years 	<ul style="list-style-type: none"> To make more seed types come on stream quicker 	<ul style="list-style-type: none"> Min of Agriculture, seed companies 	<ul style="list-style-type: none"> 2014-18 	<ul style="list-style-type: none"> Budgets of relevant agencies 	<ul style="list-style-type: none"> Number of seed types developed and disseminated within project period 	<ul style="list-style-type: none"> Seed companies prefer to stick to their old methods of seed production

4. Summary and Conclusions

The Technology Action Plan (TAP) report provides a short and comprehensive description of the action plan for adaptation technologies identified under the Water and, Agriculture and Food Security sectors. It presents the action plan which is the results of the process, which has led to a selection of several options for groups of measures described in the barrier analyses and enabling framework report. The TAP report is purely based on the content from the Barrier Analyses and Enabling Framework report.

Under the water sector, the top three technology options from which specific technologies were to be derived were according to their ranking rainwater collection from ground surfaces, boreholes/tubewells for domestic water supply, and Building a Concrete Apron/Collar on the well. It is proposed to establish a Pilot Project on Climate Change and Water access to cater for the issues observed in the main report with the pilot project targeting a total of 19,500 households in Region I.

For agriculture and food security the three top technology options were Conservation Farming, an integrated farming system of livestock-poultry-fish-vegetables which is yet to take hold among small and medium farmers, and crop diversification and new varieties. The main target groups in agriculture are the producers who belong to Region I. Depending on their scale of operation, the producers can be classified as small scale, medium scale and commercial scale producers. The producers are mostly engaged in crop, livestock and fish production as a way of increasing household food security and income levels.

The TAP report has also dealt with crosscutting issues which among others include common barriers to all the technologies identified under both sectors. In the water sector common barriers were identified with opportunities for synergies in terms of enhancing measures to overcome them, even though there were some differences in some details. The first related to the high cost of materials and equipment for technology diffusion and implementation. Building materials are expensive because of the huge infrastructure deficit the country faces. The water sector infrastructure deficit is thus just a part of the story and competition is high for materials used in construction. The second and third common barrier was the lack of technical skills and experience necessary in the designing of the technologies, and lack of skills in the construction of the technologies. It was suggested that this was due to the low number of people being trained in the necessary skills due to various reasons including high cost of training equipment. The enabling framework for overcoming the barriers in the Agriculture and Food Security Sector were presented at two levels, such as those addressing the common barriers and those barriers specific to a technology.

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- 13) Government of the Republic of Zambia, December, 2012: **Barrier Analyses and Enabling Frameworks for Climate Change Adaptation**, RuralNet Associates Limited, Lusaka
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Annex I. List of stakeholders involved and their contacts

- 1) Dr Kalaluka Munyinda, School of Agriculture, University of Zambia,
munyinda_kalaluka@yahoo.com, 0978-270898 – Key Informant Interview
- 2) Albert Chongo, Water Engineer, Water Board – Key Informant Interview
- 3) Chibesakunda, Commercial Manager, Sun Power Africa – Key Informant Interview
- 4) Gershom Chilukusha, Roads Development Agency;
- 5) Justine Chuunka, Ministry of Agriculture;
- 6) Martin Sishekanu, Climate Change Secretariat;
- 7) Excellent Hachileka, United Nations Development Programme
- 8) Ackim Mwape, Ministry of Lands, Natural Resources & Environmental Protection

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ⁱ Further details are in the Projects Ideas report

ⁱⁱ Further details in the Projects Ideas report

ⁱⁱⁱ At TNA stage, the selected technology was titled “Conservation Farming With Musangu Tree”. However, a review meeting in March 2013 resolved that this was too narrow and could not be sensibly promoted as a project for climate change adaptation. It was recommended that the technology to be promoted technology be referred to merely as “Conservation Farming With Agro-forestry”.

^{iv} The dams suitable for southern Province are usually the small size due to the land forms and topography. The cost of a typical project for a small dam, i.e. below the depth of 10m, was estimated at US\$284,000, for a medium dam (between 10 to 15m depth) US\$378,000.00 and US\$1,133,000.00 for a large dam. A small dam could hold between 500,000 to 1,000,000 Litres³ of water. This size usually supports about 100 HHs (20 villages of cluster of 5 HHs typical for this region) throughout the year (from one rain season to the next). The greatest benefit is the watering of the animals and vegetable growing. Project administration is usually at 10%, this is considered as good practice. Currently, the Water Affairs department supervises construction of an average of 4 dams per annum, this can be higher depending on the availability of funds. Maintenance is usually between 1 to 2% (We have used 2% in this calculation). There is no contribution from the community members; the present practice is that the government employs the community members to do the maintenance. Currently, there are no community members trained to undertake the dam maintenance (Interview with Mr. Albert Chongo, Water Engineer, Water Board, January, 2012).

^v SARO Agriculture Engineering and Mr. Chibesakunda, Commercial Manager, SunPower Africa, Lusaka